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Malignant Hyperthermia:
Perioperative Nurse Preparedness

by

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Abstract

Malignant Hyperthermia:
Perioperative Nurse Preparedness

by Thomas J. Flynn, Jr.

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Malignant hyperthermia (MH) is a fulminant, potentially fatal medical emergency triggered by common general anesthetics in genetically susceptible individuals. This rare hypermetabolic disorder of skeletal muscle can be prevented or treated successfully if recognized early by operating room staff who have the proper training and supplies available. The purpose of this study was to describe perioperative nurses' training and perceived educational needs related to MH; and the availability of the supplies, medication and protocol to identify and respond to an MH crisis.

A mail survey, consisting of 33 multiple choice, open-ended, and Likert-scale format questions, was designed by the researcher. The survey sample (n=496), obtained from a computer generated random sampling of actively practicing RN members of the Association of Operating Room Nurses (AORN), were sent the questionnaire by mail. The response rate was 37% (n=184).

Approximately one-third (31%) of the respondents receive only rare updates about MH. Participants identified understanding of the pathophysiology of MH and early

identification of MH symptoms as the most important topics for treating MH crises. Over 90% of respondents reported having MH supplies, protocol and dantrolene available, but only 76% of respondents reported an MH cart at their facility. The average stock supply of dantrolene available within 5 minutes was reported as 21 vials (S.D.±16), which is not enough to adequately treat a 70-kg patient. Only 53% of the sample knew that 36 vials is the recommended supply to have in stock. The Malignant Hyperthermia Association of the United States (MHAUS) is a nationwide organization dedicated to research and education about MH. MHAUS is being underutilized, only 46% of the survey respondents reporting familiarity with this important resource. The nursing profession and society may also benefit if this study leads to increased awareness and improved patient outcomes in MH crises.

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Chapter I

Problem Statement and Purpose

Problem Statement

For individuals with a genetic predisposition, malignant hyperthermia (MH) is a fulminant, potentially fatal medical emergency that is triggered by commonly used general anesthetic (GA) agents and depolarizing muscle relaxants, and which if unrecognized, can lead to a hypermetabolic disorder of skeletal muscles (Burden, 1996; Donnelly, 1994). The incidence of MH has been estimated at 1 in 12,000 pediatric and 1 in 40,000 adult anesthetic cases (Newberry, 1990). Some signs of MH occur in 1 in 16,000 people receiving GA and 1 in 4,200 people when potent inhalation agents are used with succinylcholine (Donnelly, 1994).

Although it is a rare occurrence, the nurse must always be alert for and prepared to treat MH in the perioperative setting. Perioperative nursing staff competency in identification and treatment of MH is an important aspect of preparedness (Beck, 1994). The staff must react quickly with well-coordinated responses (Grillo, 1990). Because perioperative nurses screen and manage MH patients, they must be familiar with the treatment modalities, supplies and medications (Donnelly, 1994). Research is scarce concerning perioperative nurses' knowledge and preparedness to identify and treat MH, as well as the availability of resources to treat MH. However, Reeder, Hamblet, Killen and Uruburu

(1992) and Hicks, Kneedler and Sexton (1994) surveyed perioperative nurses regarding their knowledge of HIV and surgical laser usage respectively. Both groups identified a knowledge deficit in the respondents and concluded that nursing practice could be improved with better understanding of basic theory.

MH is potentially fatal if not treated with dantrolene (Dantrium). In a nationwide survey of 183 hospitals and 50 ambulatory surgical centers, Hein (1988) reports that 9.3% of hospitals and 48% of ambulatory surgery centers were rated as incapable of handling the initial treatment of MH. Considering all factors (protocols, availability of dantrolene and supplies), 45% of the hospitals and 72% of the ambulatory surgery centers were not fully prepared. Hein (1988) believes that the mortality rate of 10-20% may be underestimated and that as many as 274 deaths may occur annually in the United States due to the nonavailability of an adequate supply of the drug. Although Hein's report is dated, in a review article Donnelly (1994) estimates a 10% mortality rate, even with the availability of dantrolene. A clear need exists for a more current study to determine if dantrolene availability is still problematic.

Early recognition of the signs of MH with rapid discontinuation of anesthesia and onset of treatment are critical for patient survival (Caine, Molla, & Reynolds, 1986). The longer the hypermetabolic response progresses,

the more difficult it is to control, and the situation becomes irreversible (Malignant Hyperthermia Association of the United States, 1992).

Purpose and Specific Aims

The perioperative nurse plays an important role in the management of MH, encompassing the preoperative, intraoperative and postoperative phases of hospitalization (Caine et al., 1986). Because little is known about the subject, the purpose of the study is to describe perioperative nurse preparedness to identify and manage MH. A description of nurse preparedness may serve to improve clinical practice and reduce the risks associated with MH for surgical patients.

The specific aims of this study are as follows:

- 1) to describe the perioperative nurses' training, level of knowledge, and perceived educational needs regarding the identification and management of MH (nurse preparedness).

- 2) to describe the availability of MH supplies, cart, medications and institutional protocol necessary to maximize patient outcomes during MH crises (institutional preparedness).

Chapter II

Review of the Literature

Background

Pathophysiology

The acute onset of MH usually occurs in the operating room (OR) or during the immediate post-operative period, but delayed onset has been reported up to 25 hours later (Murphy, Conlay & Ryan, 1984). All halothanated inhalation agents are suspect as triggers for an MH episode, as are depolarizing neuromuscular relaxants, especially succinylcholine. Amide local anesthetics (lidocaine, mepivocaine and bupivacaine) rarely cause an MH reaction but may exacerbate a crisis triggered by other agents and stress (Tomarken & Britt, 1987).

There are several theories why in MH, the calcium ion levels increase with contraction but fail to decrease preventing normal muscle relaxation. These include excess calcium release and/or decreased uptake into the sarcoplasmic reticulum, decreased uptake by the mitochondria or fragile sarcolemma allowing possible diffusion of calcium from the extracellular fluid. The net effect is that the muscle is unable to regulate calcium ion flow. The sustained contraction increases oxygen consumption and lactate production. Respiratory and metabolic acidosis occur with the increased aerobic and anaerobic metabolism. Acidosis changes membrane permeability affecting the movement of

water, ions (especially potassium and calcium), creatine phosphokinase (CPK) and myoglobin. The increased muscle metabolism results in increased production of carbon dioxide (CO_2), lactate and heat energy (Wolcott & McDonnell, 1990).

MH is manifested in several ways (Table 1). All of these signs may not be present in an acute episode. The first clinical sign, observed in 96% of MH cases, is tachycardia, usually within 30 minutes of anesthetic induction. Other early signs are unexpected end-expired CO_2 increase, hypoxemia, labile systolic blood pressure, acidosis, tachypnea and muscle rigidity (Wlody, 1991). Mortality is most often due to ventricular dysrhythmias or cardiac arrest related to hyperkalemia. Escalating fever, a late sign, causes increased cardiac output as a compensatory mechanism to meet tissue metabolic demands (Caine et al., 1986).

Treatment

Initiation of the treatment protocol depends on the prompt and accurate recognition of the signs and symptoms of MH (Table 2).

Intravenous (IV) dantrolene is the drug of choice for treating MH. It blocks the release of calcium from the sarcoplasmic reticulum which results in decreased muscle contraction, while not affecting calcium uptake (Donnelly, 1994). An initial dose of 2-3mg/kg is administered, then repeated to a total of 10mg/kg, if necessary. Although

Table 1. MH Symptoms

Symptom	Comment
-tachycardia/ventricular dysrhythmias	thought to be a result of the same MH defect in heart muscle as in skeletal muscle
-increased (doubling or tripling) end-tidal CO ₂	often the earliest sign as metabolism increases
-muscle rigidity, including masseter spasm	may occur at induction following succinylcholine making endotracheal tube or oral airway placement impossible
-tachypnea	responds to increased CO ₂ levels, may be masked by mechanical ventilation
-labile systolic blood pressure	moderate rise shortly before cardiac arrest
-cyanosis, hemoglobin desaturation	secondary to increased oxygen consumption, vasoconstriction and ventilation problems
-fever (increasing up to 2°C every 5 minutes)	late sign; the patient may already be seriously compromised
-diaphoresis	due to increased temperature/metabolism
-elevated serum potassium, CPK & lactate dehydrogenase	expected as muscle cells break down
-elevated serum calcium	falling to sub-normal levels in 1-2 hours
-abnormal ABG's	indicate metabolic and respiratory acidosis with profoundly low pH and P _a CO ₂ levels greater than 80mmHg
-myoglobinuria (MHAUS, 1992).	from muscle breakdown

Table 2. MH Protocol

Treatment Guidelines:

- Stop all potential triggering agents immediately.
- Hyperventilate with 100% O₂ at 10L/min or greater.
It is not necessary to change the anesthetic circuit.
- Administer dantrolene as soon as it is available.
- Correct metabolic acidosis with 1-2mEq/kg IV sodium bicarbonate, as guided by blood gas analysis.
- Start active cooling measures; surface cooling with cooling blanket and ice, iced normal saline for irrigation and lavage. Terminate when temperature drops to 38°C to prevent hypothermia
(MHAUS, 1993).

10mg/kg is the manufacturer's recommended limit, total doses of 20mg/kg have been given. If there is no improvement at 20mg/kg level, MH is probably not the problem (Donnelly, 1994). Although pre-treatment with dantrolene in MH susceptible (MHS) patients is usually unnecessary, MHAUS (1994) reports that a 2mg/kg IV dose prior to induction of GA may be used.

Additional treatment is determined by monitoring cardiac rhythm, arterial and venous blood gases, central venous pressure, urine output (u/o), temperature, end-tidal (ET) CO₂, potassium, calcium, CPK, LDH, clotting studies and urine myoglobin in the OR. The patient should continue to be monitored in the intensive care unit for electrolytes, enzymes, EKG, blood pressure, pulse oximetry, blood gases, temperature and urine output (which should exceed 2ml/kg/hr) for at least 24 hours.

A well-stocked malignant hyperthermia cart (Table 3) ensures that all supplies are readily available for an MH event (Wlody, 1989; Donnelly, 1994; Beck, 1994).

Nursing interventions (Table 4) are instituted to meet specific patient outcome criteria (Table 5).

Identification

Although cases have been reported in individuals less than one year old and greater than seventy years old, most occur in older children and young adults, more often in males and in Caucasians of northern European heritage

Table 3. MH Cart Supplies

Medications:

- 36 20-mg vials dantrolene sodium
- 4 500-mL bottles sterile water (preservative free) for injection, plus adapter pins or semiautomatic fluid dispensing syringes
- 6 50-mEq syringes sodium bicarbonate 8.4%
- 10 12.5-g vials mannitol 25%
- 4 100-mg syringes furosemide
- 2 50-mL syringes dextrose 50%
- 10mL vials, 100 U/mL Regular insulin (refrigerated)
- 3 10-mL vials, 1,000 U/mL heparin
- 6 1,000-mL IV bags sodium chloride 0.9% (refrigerated)

Drawer 1: Equipment

- 6 10-mL syringes & 18-gauge needles
- 1 box of alcohol prep pads & 4-oz bottle betadine paint
- 20 4 x 4 sterile gauze
- 2 tourniquets
- 2 radial artery catheters & arterial line monitoring kit
- 1 central venous pressure line kit
- 2 sets each of cassette tubing for IV pumps, IV tubing (pediatric and adult) and IV extension tubing
- 10 medication labels
- 2 wrist splints (pediatric and adult sizes)

Drawer 2: Laboratory Supplies

- 6 5-mL heparinized blood gas syringes
- 2 urine specimen containers
- 1 bottle urine test strips for myoglobin
- 6 each light blue and lavender tubes (pediatric and adult)
- 10 each gold tubes with gel and red stopper tubes

Drawer 3: Cooling Equipment

- 2 nasogastric tubes (pediatric and adult)
- 2 30-mL balloon, 3-way Foley catheters (pediatric and adult sizes)
- 2 each closed-system Foley catheter trays, peritoneal lavage trays and cystoscopy tubing
- 2 60-mL catheter tip syringes
- 2 5-in-1 connectors and Y-connectors
- 2 8-in straight Peon clamps
- 2 plastic buckets to hold ice
- 10 medium and large size plastic bags

Drawer 4: Anesthesia Equipment

- 2 each breathing circuits (pediatric and adult), breathing circuit adapters, pressure bags and soda lime canisters

Table 3. MH Cart Supplies, Continued

Miscellaneous:

- 1 sharps container
- 2 Ambu bags (pediatric and adult)
- 1 MH cart medications/supplies checklist
- 1 copy of OR team response/ anesthesia response synopsis
- 1 Malignant Hyperthermia Association of the United States (MHAUS) hotline telephone number label on the front of the MH cart: 1-800-MH HYPER (1-800-644-9737) (Beck, 1994; Wlody, 1989; Donnelly, 1994).

Table 4. Nursing Interventions

- make notification of MH crisis to front desk to obtain additional personnel
- prioritize nursing actions, coordinate care providers
- assist anesthesia in cardiac monitoring, discontinuing potential triggering agents and hyperventilating with 100% O₂.
- request additional personnel.
- obtain supplies, code cart, MH cart.
- scrub nurse loads suture for rapid closure.
- reconstitute dantrolene with preservative-free sterile water, takes at least two people.
- document sequence of events.
- handle specimens, transport or delegate.
- assist in cooling (lavage, cooling blanket, packing).
- insert Foley catheter.
- contact the MH Emergency Hotline (1-800-MH-HYPER) for assistance.
(Rothrock, 1996).

Table 5. Desired Patient Outcomes

-Maintain a patent airway and adequate oxygenation as evidenced by $S_aO_2 > 95\%$, ABG values within normal limits (WNL) for patient age and medical condition (pH 7.35-7.45, P_aCO_2 33-48mmHg, P_aO_2 80-104mmHg), respiratory rate WNL (12-18 breaths per minute) with normal breath sounds in all fields.

-Maintain adequate cardiovascular status as evidenced by absence of ventricular arrhythmias and cyanosis, heart rate (HR) $< 100/\text{minute}$, blood pressure (BP) within $\pm 10\text{mmHg}$ of baseline.

-Maintain normal fluid, electrolyte and coagulation status as evidenced by all lab values returning to normal within 48 hours, normal urinary output without myoglobinuria, and absence of disseminated intravascular coagulation (DIC).

-Maintain a core body temperature below 37.8°C as evidenced by a lack of diaphoresis, shivering or tachycardia.

-Maintain neurologic status as evidenced by absence of change of level of consciousness (LOC), absence of fever, lack of muscle rigidity or seizure activity.

-Be able (along with family) to verbalize MH signs and symptoms, safety precautions, the need for first-degree relations to pursue medical follow-up and have the name and phone number of MHAUS before discharge.

(Beck, 1994; Wolcott & McDonnell, 1990).

(Donnelly, 1994). Prevention of MH occurrence in all patients is promoted with careful preoperative screening. Identification of patients at risk is based on positive personal or family histories (Burden, 1993). Many patients with MH have had a prior anesthetic without incident (Burden, 1996; Allen, 1993). Patients with a history of an equivocal episode of MH or with first-degree blood relatives with MH should be considered MH susceptible until proven otherwise (Beck, 1994). MH susceptibility is transmitted through either a dominant or recessive gene pattern, probably involving several gene sites. At least in some families, MH is caused by a mutation in the ryanodine receptor gene on chromosome 19 (McLennan, Duff, Zorato, Fujii, Phillips, Korneluk, Frodis, Britt & Worton, 1990). Patients with a genetic predisposition may develop MH when exposed to pharmacologic triggering agents such as halothane, enflurane, isoflurane, and succinylcholine, as well as extreme exertion and emotional stress (Newberry, 1990).

Physical examination is most often normal with signs of myopathy no more prevalent in MH susceptible patients than in the general population (Allen, 1993). Certain physical characteristics are believed to occur more frequently in those susceptible: bulky muscles, frequent joint dislocations, weak muscles, or muscle disease, i.e. Duchenne muscular dystrophy, central core disease or myotonia

(Burden, 1996; Rothrock, 1996). Gronert, Fowler, Cardinet, Grix, Ellis & Schwartz (1992) report that in cases of Becker or Duchenne dystrophy, anesthesia-induced MH episodes may occur not because of the autosomal dominant MH defect, but because of the progressive deterioration of muscle membranes caused by their X-linked disorder.

Preoperative assessment by the perioperative nurse should include questions (Table 6) to screen for MH. The caffeine-halothane contracture test (CHCT) should be considered for those judged at significant risk for MH, either through family history or personal reaction to GA. CHCT is considered the "gold standard" for diagnosis of MH and entails the removal of approximately 2 grams of muscle, usually from the thigh, under a local or non-triggering anesthetic. The rate and tension of muscle contraction after exposure to halothane and caffeine determines MH susceptibility. This test is performed in only 15 locations in the United States and Canada (MHAUS, 1994).

In summary, the perioperative nurse has three main responsibilities in caring for the MH patient: preoperative assessment, preparation for MH and care of the patient during MH crisis (Wlody, 1989). The signs of MH can parallel several other perioperative complications, such as thyroid storm, septicemia or pheochromocytosis (Caine et al., 1986). The nurse must be familiar with the cause and treatment of MH in order to aggressively intervene to reduce both

Table 6. Preoperative Screening

- Is there a family history of MH?
 - Has there been an unexpected death or complication from MH in the family?
 - Is there a family or personal history of muscular disorders or weakness?
 - Is there a personal history of MH, dark urine or unexplained fever following anesthesia?
- (Rothrock, 1996).

morbidity and mortality (Wlody, 1991). Education of care providers may ensure proper patient screening and identification of at risk patients, allowing postponement of the procedure for diagnostic testing and appropriate preparation when MH susceptibility is identified. Perioperative professionals need to be familiar with written protocols so that when MH is suspected, anesthesia is stopped and prompt treatment is begun. Although the literature includes suggestions and anecdotal support for perioperative nurses' preparedness, little research is available documenting knowledge and preparedness to assess and treat perioperative emergencies such as MH.

The final vital role includes assessment of the situation, patient protection and provision of necessary equipment and supplies (Wlody, 1989). Preparedness including education, planning and communication will optimize patient safety in the perioperative setting.

Perioperative Nurse Preparation and Knowledge

Research is scarce regarding perioperative nurses' knowledge. In 1993, Reeder et al. replicated a study comparing health care workers in general with perioperative nurses' attitudes, knowledge and practice. Hicks et al. (1994) surveyed perioperative nurses attending laser education courses to assess their educational level, perceived knowledge and skill levels, and whether educational needs were being met. Both studies suggest

possible areas of knowledge deficit which may affect the nurses' practice.

Reeder et al. surveyed a stratified random population of 2,600 Association of Operating Room Nurses (AORN) members yielding a 39% return rate (n=1,015). Based on a pilot study at the 1992 AORN Congress, the direction and format of the study were modified to increase the instrument's relevance to perioperative nursing. Internal consistency and construct validity were assessed in the original survey. The survey consisted of open-ended and multiple choice questions about AIDS-related issues.

The researchers had expected that the results of this study would differ from the original 1991 survey because of widely publicized events that had occurred since the 1991 study and probable increase in knowledge regarding risk-reduction as a result of education mandated by the Occupational Safety and Health Administration (OSHA). Differences in knowledge, attitudes and practice were analyzed based on demographic characteristics of nursing role, education and age and were reported as frequencies. To answer whether differences existed between health care workers and specifically perioperative nurses, the responses were compared between the original study and the AORN study. Group differences were assessed with unpaired t-tests.

Despite a two-year lapse time between studies and additional information becoming available to health care

workers, there were only slight differences between the responses of the two groups. The authors speculated that being a member of a specialty nursing association and receiving publications and continuing education would have a positive impact. However, less than two-thirds of the AORN nurses correctly answered any knowledge or recommended practice question. The authors conclude that nurses must become more knowledgeable and sensitive to the needs of AIDS patients since practice is a reflection of knowledge and attitude.

Hicks et al. surveyed perioperative nurses (n=159) at four different laser education courses in 1989 and 1991. The researchers used questions with open-ended, binary and Likert response formats. Replies to the perceived knowledge and skill questions were validated by responses to an open-ended question describing areas in which the respondents needed more education. Advanced level nurses were found to be more highly trained and experienced than nurses in the basic level groups. Respondents rated themselves as most knowledgeable about safety precautions regarding electricity, laser plume, eye protection, environmental hazards and disinfection of laser accessories, perhaps due to a preponderance of educational experiences related to these topics. Respondents rated areas such as calculating optical density, laser ergonomics, beam alternations and permissible exposure levels outside their expertise. The

authors conclude that for nurses to respond in an emergency, they must understand the theory behind their actions. While safety is of paramount concern, rote learning of such practice is pointless unless grounded in the basic science of lasers. This study is limited by the convenience sampling of a small number of nurses in the western United States attending laser education courses which are not representative of all nurses and their needs.

These studies suggest methods of assessing the knowledge of perioperative nurses regarding selected topics. However, no study has been published to date indicating perioperative nurses' responses regarding MH. The researcher, by clinical observation, has identified the need for standardization of training and available supplies with the aim to improve response time and optimize patient outcomes during an MH episode. Conducting a nationwide survey of randomly selected nurses may create a more realistic picture of perioperative nurses' preparedness in treating MH and help in identifying educational needs.

Chapter III

Methodology

Design

This research study is a descriptive survey of perioperative nurses' preparedness to intervene in an MH crisis. This design was chosen to gain information about characteristics without manipulation of variables (Burns & Grove, 1993). The study describes the demographics, institutional capabilities, knowledge and perceived educational needs regarding MH, of a representative sample of perioperative nurses who are members of the Association of Operating Room Nurses (AORN).

Sample

A survey was mailed to each of a computer generated random sampling of 496 AORN members, representing 1.1% of AORN's total active membership. The nationwide sample included male and female Registered Nurses (RN's) actively practicing in a perioperative setting during the previous year in the United States and who are members of AORN. Currently nonemployed members, non-RN's, international members, researchers and Certified Registered Nurse Anesthetists (CRNA's) were excluded because their training may differ from the perioperative nurses. The sample size was limited by the constraints of time and the financial resources of the investigator. The goal was to have a minimum of 100 questionnaires completed and returned.

Instrument

A cover letter (Appendix A) served to introduce the study. The survey (Appendix B), developed by the investigator, consisted of 33 questions with open-ended, multiple choice and Likert response formats. The questions progressed from non-threatening demographic questions to self-assessment questions. The demographic questions covered education, experience, current employment, age and gender. These were followed by specific questions investigating institutional capabilities, basic knowledge regarding MH and perceived educational needs of the respondents (Hicks et al., 1994).

The questionnaire was pre-tested for validity and reliability. Three experts, who reviewed the questionnaire to establish content validity, assured that the questions reflected the purpose and specific aims of the study. Two of the experts were selected for their experiences with responding to MH crises, the third specifically for her research background. All three experts are perioperative nurses with a minimum of nine years of perioperative nursing experience and education levels varying between an associate degree and a master's degree in nursing. A pilot study of the instrument was also conducted. The ten pilot study participants were informed of the study's purpose and instructed to evaluate the time needed to complete the survey, the clarity of the questions and to suggest possible

revisions to the survey (Appendix C). Three of the ten pilot respondents were asked to repeat the survey two weeks later to demonstrate test-retest reliability. Burns & Grove (1993) recommend that with paper and pencil tests, at least a two week period between tests to show the stability and consistency of repeated measures. Internal consistency is not measurable in this instrument due to the variable response format and multi-dimensional nature of the instrument.

Procedures and Protocols

Approval was obtained from the University of Washington Human Subjects Review Committee and AORN prior to the pilot study. Ten currently employed perioperative nurse colleagues of the investigator pilot tested the survey. The pilot study participants were mailed a survey and instructed to complete and return the survey to the investigator within one week of receipt via the self-addressed stamped envelope (SASE) enclosed. Revision of the survey was made based on the results. These responses were not included in the final study. While the likelihood is small that the pilot respondents would be randomly selected for the nationwide study, they were asked not to complete the questionnaire should the case arise.

Revised surveys were mailed to the computer generated stratified random sample of 496 AORN members. The cover letter and survey contained the introduction and directions

for completion. The participants were requested to return the survey within two weeks of receipt. A follow-up reminder postcard (Appendix D) was mailed to all potential participants two weeks after the initial survey mailing to prompt return of the surveys. Completing and returning the survey implied consent to participate in the study.

Analysis

Descriptive and comparative data from the survey were quantified, then analyzed using statistical methods found in the Statistical Package of the Social Sciences (SPSS). The results were reported as summary statistics, including percentages, means, and standard deviations. Parametric correlations (Pearson's r) were analyzed for selected relationships between demographic variables and nurses' knowledge levels. A statistician was consulted to further guide appropriate methods for the study.

Human Subjects

The research proposal was submitted to the University of Washington Human Subjects Committee for approval of exempt status. An abstract was also sent to AORN for approval.

The study exposed participants to no physical risk or cost, other than the time needed to complete and return the questionnaire. Individual subjects did not directly benefit from participation. However, a potential risk of discomfort from lack of knowledge may have motivated the participant to

seek further education regarding MH. The nursing profession and society may benefit from improved perioperative nurse preparedness to respond to an MH crisis.

Participation in the study was strictly voluntary. The confidentiality of the participants was guaranteed by marking the surveys with an identification number only. Participants who were interested in receiving a copy of the abstract and the study findings were directed to complete the form at the end of the survey, detach and return it in the SASE with the survey. Requests were separated from the survey immediately after opening the envelopes by a disinterested third party. The disinterested third party also discarded the follow-up postcard of these participants. Remaining potential participants received the follow-up postcard.

Chapter IV

Results

Introduction

The names and addresses of 500 randomly selected members was purchased from AORN on self-adhesive labels. The researcher, along with three members with military overseas addresses, were rejected for not meeting the inclusion criteria. A total of 184 of 496 (37%) of the surveys were returned. Seven of these surveys were rejected due to the member's inactive status. The remaining 177 of 496 (36%) were coded and used in data analysis. Approximately one-third ($n=64$, 35%) of the respondents requested and will receive a copy of the study abstract and findings. This chapter describes the demographics of the respondents, their training and knowledge, and institutional preparedness to treat MH.

Description of the Sample

The demographic characteristics of the respondents were compared with the AORN membership data, when available, provided by AORN as Membership Statistics for January 1997 (Table 7). The characteristics analyzed include age, gender, job position held during the previous year, level of basic nursing education, highest nursing degree held, years of professional nursing and perioperative nursing experience, facility of which primary employment, number of surgeries performed monthly in this facility and state in which the

member practices. Questions regarding participation in MH crises and number of cases responded to were also included in the survey.

The respondents to the survey were asked to report their age (question #32). The study participants were slightly underrepresented in the 40-49 year age group and slightly overrepresented in the over 50 years age group when compared to the AORN membership (see Table 7). The study sample consisted of predominantly female respondents, comparing almost exactly with AORN membership. Nearly three-fourths of the study respondents are staff nurses. Clinical nurse specialists, nurse managers, nurse educators, RNFA's and nurse practitioners account for the remainder of the participants. The proportion of the work roles of study participants closely approximate the AORN membership, although staff nurses and clinical nurse specialists are overrepresented in the survey sample by approximately 10%. Most of the participants are employed fulltime.

Survey respondents were asked to report their level of basic nursing education (question #28) and highest nursing degree held (question #29). Only one-fourth of the respondents entered nursing with a baccalaureate degree (BSN), although 41% have attained that educational level. The study sample matches up well with the AORN membership on highest nursing degree held, with the biggest difference being found between the survey sample population and AORN

Table 7. Comparison of Survey Sample and AORN Membership

Demographic Variable	Sample Freq. (n)	Sample (%)	AORN (%)	Difference (%)
Age in years				
Sample AORN				
20-29 <30	9	5	5	0
30-39 31-40	49	28	27	1
40-49 41-50	61	35	41	-6
>50 >51	56	32	27	5
missing	2			
Gender				
Male	8	5	5	0
Female	168	95	95	0
missing	1			
Job Position				
Staff Nurse	126	72	59	13
Nurse Manager	18	10	11	-1
CNS	10	6	2	4
Educator	10	6	4	2
RNFA	5	3	4	-1
other	5	3	20	-17
Practitioner	1	0	0	0
missing	2			
Basic Nursing Education				
Diploma	82	47	N/A	N/A
ADN	48	27	N/A	N/A
BSN	45	26	N/A	N/A
missing	2			
Highest Education				
Diploma	62	36	31	5
ADN	37	21	25	-4
BSN	62	36	26	10
MS/MN	12	7	3	4
Doctorate Nsg.	1	0	0	0
other			15	N/A
missing	3			
Employment Status				
Fulltime	144	83	N/A	N/A
Parttime	25	14	N/A	N/A
Per Diem	6	3	N/A	N/A
missing	2			

Table 7. Comparison of Survey Sample and AORN Membership, Continued

Demographic Variable	Sample Freq. (n)	Sample (%)	AORN (%)	Difference (%)
Facility				
Community hospital	106	61	N/A	N/A
Academic med center	39	22	N/A	N/A
Surgical ctr	18	10	N/A	N/A
Clinic/office	5	3	N/A	N/A
Military hosp	4	2	N/A	N/A
other	3	2	N/A	N/A
missing	2			
Region of Practice				
Northeast (ME, VT, NH, CT, MA, RI)	12	7	6	1
Mid-Atlantic (NY, NJ, PA)	24	14	15	-1
So. Atlantic (DE, MD, DC, VA, WV, NC, SC, GA, FL)	36	21	19	2
East No. Central (OH, IN, IL, MI, WI)	28	16	16	0
East So. Central (KY, TN, AL, MS)	7	4	5	-1
West No. Central (MN, IA, MO, ND, SD, NE, KS)	11	6	7	1
West So. Central (AR, LA, OK, TX)	11	6	11	-5
Mountain (MT, ID, WY, CO, NM, AZ, UT, NV)	12	7	6	1
Pacific (WA, OR, CA, AK, HI)	34	19	14	5
missing	2			

Table 7. Comparison of Survey Sample and AORN Membership,
Continued

Demographic Variable	Sample Freq. (n)	Sample (%)	AORN (%)	Difference (%)
Experience with MH Occurrence				
Yes	40	23	N/A	N/A
No	136	77	N/A	N/A
Don't know	1	0	N/A	N/A

All percentages are reported as percents of valid answers.

members with a BSN level education.

Respondents reported a mean of 20 (S.D. \pm 10, range 1-48) years of professional nursing experience (question #26). They reported a mean of 16 (S.D. \pm 9, range 1-47) years of perioperative nursing experience (question #27). Most participants had some nursing experience outside of the operating room.

Respondents were asked to categorize the type of facility in which they are primarily employed, along with the number of surgical cases performed at their facility monthly. The majority (61%) reported that they are primarily employed in a community hospital. The entire sample reported a mean of 557 (S.D. \pm 411, median 500, range 20-3000) surgical cases performed monthly.

The survey sample was distributed across the fifty United States and Washington, D.C., as is AORN's American membership (Table 7), but did not include military members with overseas addresses, members in American territories or AORN's foreign membership. No surveys were returned from members in Alaska, Delaware, Hawaii, Kentucky, Louisiana, Maine, Mississippi, Nebraska or North Dakota.

Respondents were asked to report if they had ever participated in the treatment of an MH crisis (question #4) and if so, how many times (question #5). Although MH is a relatively rare occurrence, almost one-fourth (23%) reported having any experience in treating an MH crisis, with one

nurse reporting 5 cases.

Nurse Preparedness

The first specific aim of the study was to describe the perioperative nurses' training, level of knowledge, and perceived educational needs regarding the identification and management of MH. Participants were asked to indicate when they received their MH training, the methods used and frequency of updates (questions #1-3). General knowledge about MH was assessed with five multiple choice questions (#13-15, 17&18). Respondents were then asked to rate their knowledge, to identify the 5 most important areas of education needed, and to indicate the single most difficult aspect to comprehend which they believe to be essential to the treatment of MH (questions #20&21).

Training

Alarminglly, 31% of respondents reported that they rarely update their knowledge about MH, and 3% said that they never update their knowledge. About one-half of the nurses (52%) report receiving annual updates, whereas 9% receive semi-annual and 3% biennial training updates. Also surprising was that only 46% reported that they were familiar with MHAUS, which is the only health organization totally dedicated to the control of MH (MHAUS, 1995).

Respondents were asked to relate their source(s) of MH training. The most frequent source of training was an MH inservice, reported by 75% of respondents. Others reported

continuing education (43%), education during perioperative training (19%) and basic nursing education (14%). Other answers include training by anesthesia, at AORN meetings and via the internet. Only one respondent reported no training.

Training methods varied between lectures (82%) and handouts (71%), films/videos (51%), hands-on (19%) and MH mock code (14%). Others included reading, review of research and the internet.

Respondents were also asked to relate specialized certifications or credentialing, which is generally not required but demonstrates additional training. Almost two-third (64%) are Certified Operating Room Nurses (CNOR's), and one-third of the respondents (31%) report having Advanced Cardiac Life Support (ACLS) certification, and 5% are Registered Nurse First Assistants (RNFA's). The remaining respondents reported certification in such specialties as Oncology, Gerontology, Chemotherapy, Medical-Surgical and Critical Care Nursing.

MH Knowledge

Respondents' knowledge of the basic pathophysiology of MH, early versus late signs, testing and anesthetic triggers were assessed with multiple choice questions. Three-fourths (76%) correctly identified calcium as the ion that the muscle is unable to regulate. Three-fourths (74%) of the respondents also knew that any local anesthetic is safe to use with MH susceptible patients. Nearly three-fourths (71%)

correctly selected hyperthermia as a late sign from among a group of early signs of MH. When asked how a definitive diagnosis is made, about one-half (59%) correctly identified the halothane-caffeine contracture test. Similarly, about one-half (55%) of the respondents correctly answered that MH is a disorder of skeletal muscle.

Overall, just under one-fifth (19%) of the respondents answered all five questions correctly. One-fourth (24%) answered three to four questions correctly. A small proportion of the respondents answered two (16%), one (11%), and or none (6%) of the questions correctly. The ability to correctly answer all five multiple choice MH knowledge questions was unrelated to the level of the highest nursing degree earned (Pearson $r=-0.012$, $p>0.05$). A significant but small relationship was found between the number of correct answers and the number of years of perioperative experience (Pearson $r=0.163$, $p<0.05$). That is, the more years of experience, the more knowledge questions the respondents tended to answer correctly.

Knowledge Self-Assessment

Respondents were asked to rate themselves as: (1) having no knowledge, (2) at the beginner level, (3) moderately knowledgeable, (4) very knowledgeable, or (5) extremely knowledgeable. The categories rated include knowledge of the MH cart, cooling measures, medications, lab values, MHAUS, pathophysiology, incidence, prophylactic

Table 8. Knowledge Self-Assessment

Area	Knowledge Level				
	none (%)	beginner (%)	moderate (%)	very (%)	extreme (%)
MH Cart	8	22	38	22	11
Cooling	5	17	40	27	12
Medi- cations	6	31	39	15	7
Lab values	13	42	33	12	1
MHAUS	32	33	23	8	3
Patho- physiology	7	44	42	7	1
Incidence	5	28	45	18	5
Prophy- laxis	12	38	37	9	4
Protocol	3	24	48	18	6
Risks	7	31	42	16	4
Diagnosis	13	46	31	9	2
Triggers	7	34	38	16	5

treatment, risk factors, treatment protocols, diagnostic testing and anesthesia drug triggers (Table 8). Greater than 30% of the respondents rated themselves as very or extremely knowledgeable about only the MH cart and cooling interventions. Less than 12% did so when describing their knowledge of the pathophysiology, diagnosis or prophylactic treatment of MH, interpretation of lab values or MHAUS.

Perceived Educational Needs

Table 9 lists the most important knowledge areas which at least one-fifth (20%) of the respondents felt was needed to function during an MH crisis. Clearly the most frequently mentioned item was a knowledge of treatment protocol, with almost one-half of the respondents indicating this need. Other areas named less frequently include MH code practice (18%), interpreting lab values (16%), anesthesia triggering agents (15%) and the perioperative nurses' role (10%).

When asked to specifically name, in their opinion (question #21), the single most difficult aspect to comprehend to competently intervene in an MH crisis, the most common answers were pathophysiology (17%) and early detection (16%). MH drugs was listed (7%), along with remaining current, triggering agents, lab values, the nurse's role, MH screening, prevention and knowledge of equipment. It should be noted that mixing dantrolene is frequently considered by respondents as separate from understanding of MH medications.

Table 9. Respondent-Identified Educational Needs

Knowledge Area (Percentage of Respondents)

- 1.MH treatment protocols (48%)
- 2.Early recognition of MH signs (38%)
- 3.Medications (31%)
- 4.Location of supplies/MH cart (29%)
- 5.Preoperative screening/risk factors (28%)
- 6.Cooling interventions (27%)
- 7.Familiarity with supplies/MH cart (22%)
- 8.Mixing dantrolene (20%)

Institutional Preparedness

The second specific aim of the study was to describe the availability of MH supplies, cart, medications and institutional protocol necessary to maximize patient outcomes during MH crises.

Three-fourths of the respondents (76%) reported an MH code cart in the facilities where they are employed. Almost all (97%) reported MH supplies as readily available, as well as having dantrolene in stock (99%, n=175). Two respondents did not know if dantrolene is stocked.

Dantrolene is most often stocked (question #11) in an MH code cart (67%, n=119). In some facilities, dantrolene is divided between the pharmacy and the MH code cart (14%, n=25) or available only from the pharmacy (9%, n=16). Dantrolene is also stocked in the anesthesia workroom (7%), or on another unit such as the PACU (6%). Dantrolene is less often stocked in the drug room, front desk, refrigerator, anesthesia carts, crash cart, or in the MH supply area/box. Some (3%) did not know where dantrolene is stocked.

An average of 21 (S.D.±16, range 2-90) vials of dantrolene are reported to be available within 5 minutes (question #12). Many (n=48) of the invalid responses included simply "enough", or "plenty", or "don't know". When asked the recommended stock level of dantrolene in a multiple choice question (#16), slightly more than one-half (53%, n=74) answered 36 vials correctly.

Finally, when asked if their work area had a written protocol, algorithm or operating instruction for MH treatment, 91% (n=161) answered yes, 3% (n=6) said no and 6% (n=10) did not know.

Chapter V

Discussion

Introduction

This chapter consists of a discussion about the important findings related to nurse and institutional preparedness; strengths and weaknesses of the design; significance to perioperative nursing; applicability to the military health care environment; and suggestions for further research.

Nurse Preparedness

The results of this study suggest that, although MH is a rare but potentially fatal medical emergency, approximately one-fourth of perioperative nurses are likely to encounter this clinical challenge at least once in their professional career. Because perioperative nurses need to be prepared for this life-threatening emergency, a regular program of training should be implemented nation-wide that incorporates knowledge and demonstration of skills. According to the results of this study, only one-half of the nurses surveyed report receiving annual updates, and approximately one-third of the respondents receive infrequent, if any, regular instruction on the assessment and management of MH crisis. It is not known whether the educational offerings consist of knowledge and/or skills demonstration.

The cardiopulmonary resuscitation (CPR) training

programs could provide a model to develop an MH training program. Cavanagh (1990) reported that, with CPR training, written materials were helpful in improving knowledge. Similarly, nurses in the current study indicated that lectures and written or audiovisual materials were the most common methods of updating their knowledge about MH. However, knowledge alone is insufficient to guarantee timely, efficient responses to an MH crisis. Indeed, Cavanagh (1990) found that improvement in motor skills did not occur in conjunction with improved knowledge about CPR performance. It is difficult to learn complicated procedures and translate theory into practice in the classroom alone (Cavanagh, 1990). Grillo (1990) reports that after an MH mock code demonstration, policy and procedures were revised, and supplies were rearranged in the MH cart to expedite access. Familiarization with reconstitution of dantrolene using semiautomatic fluid dispensing syringes was also accomplished (Grillo, 1990). Thus, reconstitution of dantrolene should be included as a skills component, especially considering that 20% of respondents in the current nation-wide survey listed mixing dantrolene as one of the five most important areas of education needed. Indeed, seven individuals selected dantrolene reconstitution as the most important area of education. Since few (14%) of the respondents have ever participated in a mock MH code, a standardized program of MH training could include a mock

code to demonstrate application of learned knowledge and skills.

Results of the current study support the importance of conducting a needs assessment of perioperative personnel, since more than one-half of the respondents indicated only a basic knowledge level of MH. The needs assessment and subsequent curriculum components could be organized according to the following areas most frequently mentioned by respondents as deficits in knowledge (Table 9). Results of the current study suggest that several knowledge areas, pathophysiology and early detection of MH, would need particular attention because these areas were rated singularly the most difficult aspects to understand.

Institutional Preparedness

Even if nurses are prepared to encounter an MH crisis, the institution should provide the resources for nurses to function. According to the results of the study, most institutions have a protocol, algorithm, or operating instruction for MH treatment. Most institutions also have an MH code cart available to perioperative nurses. However, only one-half of the respondents indicated a specific number of dantrolene vials available. It is unclear as to whether the respondents did not know or were unable to obtain an accurate number. The average number (mean=21 vials) was insufficient according to the MHAUS (1994) standard, whereby 36 20-mg vials should be available to treat a 70-kg patient.

Judging by the fact that only one-half of the respondents knew the recommended level of dantrolene, nurses and nurse administrators should be educated about the number of dantrolene vials that should be available for immediate use. At the price of \$47/vial, and a shelf-life of three years, the cost of maintaining a stock of 36 vials is <\$600 annually (MHAUS, 1994). Thus, a properly stocked MH cart constitutes a very small portion of an OR budget.

Strengths and Weaknesses

The survey sample closely resembled the general AORN membership according to age, gender, highest education level and job position. The survey sample is, however, limited to AORN members only and may not be representative of the perioperative nurse population in general. As members of a professional organization, AORN members may be more experienced, more educated and be more active in their profession than their peers. Therefore, the findings of this study cannot be generalized beyond the sample population. There also may be a significant differences between respondents and non-respondents, nurses with less knowledge or negative feelings regarding the survey may not be represented.

The survey tool, created for this study, is in the initial phase of content validity as established by an expert panel. Three members of the pilot study repeated the survey to show test-retest reliability. The use of the

survey format somewhat limits the respondents' ability to reply or describe in detail. Instructions cannot be clarified and are left open to individual interpretation. Questions #20&21, based on a previous study of lasers by Hicks et al.(1994), requesting the respondent to specifically name education needs, often proved to be either too burdensome or the wording unclear to the respondents, as noted in comments or failure to answer. Question #11 should be modified to allow respondents to report when dantrolene is stocked in more than one place. Question #12 did not elicit the specific answers desired from all respondents. Directions not to consult external sources may have made the respondents hesitant to look in the MH cart, although no respondents reported that their MH cart was locked. Lastly, there is always the potential with self-reporting of deliberate or unconscious distortion, as well as errors in data reporting.

Implications for Perioperative Nursing

MH is clearly an important topic for perioperative nursing practice. At the very least, the importance of MH preparedness has been underscored by the results of the current study. According to anecdotal evidence, several survey participants were stimulated to review or seek additional knowledge as a result of participating in the study. Training in an MH mock code and mixing dantrolene, in particular, are deemed by respondents to be important; the

pathophysiology of MH was considered the top educational need. Only 76% of respondents reported that their facility had an MH cart; cost of a properly stocked MH cart need not be prohibitive. MHAUS as a nationwide resource is found to be greatly underutilized; awareness of this important resource is most important. Finally, OR managers may be prompted to examine the need for standardization of MH treatment protocols and supplies, with adaptable education and training methods to promote optimal learning conditions.

MH and Military Health Care

MH affects every segment of the military patient population, from newborn to the older adult. Military perioperative nurses must be ready to respond to an MH crisis in any setting, from the routine peacetime scenario, to active zones of conflict. Consequently, materials must be readily available to treat an MH crisis. The nurse must be ready to act under any conditions where backup may not be available. Increased awareness of MH is also needed to screen out individuals susceptible to MH prior to deployment, or preferably, from duty entirely during entrance physicals.

The prevalence of small operating room teams at many Air Force facilities worldwide, often with only 2 or 3 nurses assigned, and the frequent after-hour call cases, means that every nurse must have the knowledge and training to insure the optimal patient outcomes. Even remote sites

could receive independent modular training on videotape with the inclusion of an annual MH mock code. This need is exaggerated even more by trends in downsizing and the need to "do more with less". By adopting a standard MH protocol, MH code cart and supplies, and promoting awareness at every military surgical facility, this may be accomplished.

Suggestion for Further Research

No previous published studies were identified that examined perioperative nurses' preparedness to respond to an MH crisis. Studies of CPR education have shown that determination of a staff's ability or performance level in skills needing reinforcing, should be the first priority (Boudin, 1995). Research on CPR education also suggests that loss of knowledge and skills following training occurs with all groups and does not follow consistent patterns. Selective retraining may allow students to build on prior experience contributing to motivation and self-esteem (Cavanagh, 1990).

Frequency of retraining will depend on the nurses' role and be done as often as needed (Boudin, 1995). The optimal training method must then be selected, with cost likely to be a key factor. Coleman, Dracup and Moser (1991) report that the most frequent form of CPR instruction is the classroom, or didactic, technique. It also requires a great deal of instructor time and is expensive. The authors' experimental modular instruction, on the other hand,

consisted of independent or computerized instruction with visual and auditory aids, written guides, handouts and a taped narrative. Little difference was found in learning and retention between the didactic and modular forms of instruction, but the modular method did allow more frequent training at less cost (Coleman et al., 1991). Further research may help to clarify specific learning needs, and the optimal frequency and methods to ensure that perioperative nurses are prepared to respond to an MH crisis.

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Appendix A

Cover Letter

Dear AORN Member,

As a member of AORN and a graduate student at the University of Washington School of Nursing, I have a special interest in the topic of Malignant Hyperthermia (MH). I am conducting a survey to assess perioperative nurses' preparedness to intervene in MH crisis by examining your experience, training, knowledge, institution resources and perceived educational needs in this area. Completion of the survey should take approximately 20 minutes of your time.

Your name has been selected randomly from the current membership of AORN. Participation is strictly voluntary. There are no risks to you. To insure your confidentiality, please do not write your name or address on the questionnaire, except on the form at the end of the survey if you are requesting a copy of the abstract and study findings. This form will be separated from the survey by a disinterested third party immediately upon opening the envelope. Only the research team will have access to the data. The findings will be available in the University of Washington Health Science library as a thesis and may be published in professional journals.

By completing and returning the enclosed survey you are implying your consent to participate in this study. Please answer the questions to the best of your ability without consulting other sources and return **only** the questionnaire in the self-addressed stamped envelope within 2 weeks. You will receive a reminder letter in 10 days. Thank you for your participation in this nursing research study.

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Thomas J Flynn, Jr. is a regularly enrolled graduate student at the University of Washington School of Nursing. Any help you can give with this study will be greatly appreciated.

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Appendix B

Malignant Hyperthermia Questionnaire

The purpose of this questionnaire is to describe your background, work environment, knowledge and needs related to Malignant Hyperthermia (MH). Please complete each response to the best of your ability without consulting external sources, by circling the best answer or filling in the blank.

1. Describe your training related to Malignant Hyperthermia:
(circle all that apply)
 1. Self taught
 2. On the job experience
 3. Nursing school
 4. Inservice
 5. Continuing education
 6. Perioperative training/internship
 7. other _____
 8. none
2. What methods did your training technique include:
(circle all that apply)
 1. Lecture
 2. Films/Videos
 3. Handouts
 4. Hands-on
 5. MH Mock Code
 6. other _____
3. How often do you update your knowledge about MH?
 1. Never
 2. Rarely
 3. Semi-annually
 4. Annually
 5. Biennially
 6. other _____
4. Have you ever participated in the treatment of an MH crisis?
 1. Yes
 2. No
 3. Don't know
5. If yes, approximately how many MH cases have you responded to? ____
6. Are you familiar with the Malignant Hyperthermia Association of the United States (MHAUS)?
 1. Yes
 2. No

7. Does your work area have a written protocol, algorithm or operating instruction regarding MH?

1.Yes 2.No 3.Don't know

8. Are MH supplies readily available in your workplace?

1.Yes 2.No 3.Don't know

9. Does your institution have an MH code cart?

1.Yes 2.No 3.Don't know

10. Is dantrolene sodium (Dantrium) stocked in your institution?

1.Yes 2.No 3.Don't know

11. If so, where?

1.MH code cart in OR
2.Pharmacy
3.Shared with another unit
4.other _____
5.Don't know

12. How many vials of dantrolene are available to you within 5 minutes of identification of an MH crisis? _____.

13. MH is a disorder of _____ muscle.

1.smooth 2.cardiac 3.skeletal 4.all of the above

14. The muscle is unable to regulate _____ ion flow.

1.calcium 2.potassium 3.magnesium 4.sodium

15. One of the late signs of an MH crisis is _____.

1.masseter muscle spasm 3.elevated end-tidal CO₂
2.tachycardia 4.hyperthermia

16. MHAUS recommends a stock level of _____ vials of dantrolene.

1.10 2.25 3.36 4.100

17. _____ is considered a safe anesthetic agent for MH susceptible patients.

1.Succinylcholine 3.Enflurane
2.Isoflurane 4.Any local anesthetic

18. Definitive diagnosis of MH is made based on:

1.family history 3.a halothane-caffeine contracture test
2.muscle weakness 4.patient symptoms

19. Rank your knowledge level in the following areas of MH management.

Please circle: 1=no knowledge,
 2=beginner,
 3=moderate knowledge,
 4=very knowledgeable,
 5=extremely knowledgeable.

Pathophysiology	1	2	3	4	5
Pre-op screening risk factors	1	2	3	4	5
Family prevalence/ genetics	1	2	3	4	5
Anesthetic drug triggers	1	2	3	4	5
Treatment of MH/ protocols	1	2	3	4	5
Monitoring lab values	1	2	3	4	5
Dantrolene/ medications	1	2	3	4	5
Cooling interventions	1	2	3	4	5
Diagnostic testing	1	2	3	4	5
Prophylactic treatment	1	2	3	4	5
MH cart	1	2	3	4	5
MHAUS	1	2	3	4	5

20. In your opinion, the 5 most important areas of education needed by nurses to function optimally during an MH crisis are:

1. _____
2. _____
3. _____
4. _____
5. _____

21. What is the single most difficult aspect to comprehend which you believe is essential knowledge in order for you to be competent in MH intervention? Be specific.

22. Position during the past year:

1. Staff Nurse
2. Nurse Manager (Administrator)
3. Nurse Practitioner
4. Clinical Nurse Specialist
5. other (please specify) _____

23. Employment status in Nursing during the past year:

1. Full time
2. Part time
3. Per diem
4. other (please specify) _____

24. Facility in which primarily employed:
1.Community hospital
2.Academic Medical Center
3.Surgical Center
4.Clinic/Doctor's Office
5.Military hospital
6.other_____
25. Approximately how many surgical cases are performed at your facility monthly?_____
26. Years of professional nursing experience:_____ years.
27. Years of perioperative nursing experience:_____ years.
28. Basic Nursing education:
1.Diploma
2.Associate degree
3.Baccalaureate degree
4.other_____
29. Highest Nursing degree attained:
1.Diploma
2.Associate degree
3.Baccalaureate degree
4.Master's degree
e.Doctorate
30. Additional certifications (circle all that apply):
1.ACLS 2.CNOR 3.CRNFA 4.other_____
31. Gender:
1.male 2.female
32. Age:
1.20-29 yrs
2.30-39 yrs
3.40-49 yrs
4.50-59 yrs
5.60 yrs or over
33. State in which you practice_____

34. Please write any additional comments

Thank you for completing the survey. Please return the survey within 2 weeks in the self-addressed stamped envelope.

&.....

For a copy of the abstract and study results, separate here and return in the self-addressed stamped envelope with the survey.

Name and address:

Appendix C

Pilot Study Letter

Dear Perioperative Nurse Colleague,

You have been selected to participate in the pilot study of this survey of perioperative nurses' preparedness to respond in a Malignant Hyperthermia crisis. Please complete the attached questionnaire with the following questions in mind. Your input will be used to improve the survey. If you receive a questionnaire during the nationwide survey, please do not participate in the study.

1. How many minutes did it take to complete the questionnaire?

2. Are the questions and directions clearly written? Be specific.

3. Should any content be omitted? Be specific.

4. Should any content be added? Be specific.

5. Additional comments.

Thank you for your interest in this nursing research study.

Appendix D

Follow-Up Postcard

Dear AORN Member,

A questionnaire was recently mailed to you requesting information describing perioperative nurse preparedness to respond in a Malignant Hyperthermia crisis. If you have completed and returned the survey, thank you for your participation. If you are planning to be a part of this nursing research, please complete and return the questionnaire at your earliest convenience.

Thank you for your interest in this study.

Thomas J. Flynn Jr. RN, BSN, CNOR
Graduate Student
Dept. of Biobehavioral Nursing & Health Systems
University of Washington, Seattle

16005 175th Ave NE
Woodinville, WA 98072
(206) 402-6971

PLEASE MAKE SURE YOU FILL THIS SHEET OUT

MAIL THIS FORM WITH YOUR TRAINING REPORT INPUTS IN A
SEPARATE ENVELOPE FROM YOUR SURVEY RESPONSES

Thomas J. Flynn, Jr.
NAME

PART V - OTHER QUESTIONS

1. What will your rank be on your completion date? Captain
2. What is the address of your follow-on PCS assignment following your AFIT tour? Do not list TDY en route.
60th Medical Group
Travis AFB, CA 94535

3. Who is your AFIT Program Manager? (If more than one, list all)
Capt John Johnson

**MAIL THIS PORTION DIRECTLY TO YOUR PROGRAM MANAGER IN THE
SMALL ENVELOPE PROVIDED ALONG WITH YOUR NEXT ASSIGNMENT
INFORMATION**

OFFICERS: TRAINING REPORT INFORMATION

YOUR NAME & RANK

Capt Thomas J. Flynn, Jr.

YOUR AFIT COMPLETION DATE 06 JUN 97

YOUR PROGRAM MANAGER Capt John Johnson

INPUTS FOR TRAINING REPORT: Please include thesis title and sponsor (if any), papers presented or published, academic/professional activities (including any awards or honors), military activities (LO, work with local AFROTC or recruiters), and noteworthy service activities (Scouts, church, etc). Please help us make your TR as strong as possible!

Successfully completed Master of Nursing degree from challenging graduate program at the University of Washington with outstanding cumulative GPA of 3.75/4.0.

Completed exceptional thesis entitled: "Malignant Hyperthermia: Perioperative Nurse Preparedness":

- described perioperative nurse and institutional preparedness to respond to this potentially fatal medical emergency.
- in a nationwide survey of perioperative nurses, identified knowledge deficits re: MH and availability of the critical drug dantrolene.
- may serve to guide development of education programs for civilian or military perioperative nurses.

Team leader and aerobics monitor for 6 member team of AFIT students, acting as first line of contact, counsellor and monitor of team member's status.

Acting L.O. for entire 30 member AFIT team at the University of Washington when Maj Bridges on leave over Christmas holidays.

Enthusiastically promoted AF nursing to ROTC students, sharing professional experience and commitment to the AF by example.

Volunteered to act as Investigating Officer on complicated, time-consuming case of cadet disenrollment at the ROTC DET.

Off duty, volunteered to coach community Little League baseball team.

DEPARTMENT OF THE AIR FORCE
DETACHMENT 910, AIR FORCE ROTC (ATC)
UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON 98195

MEMORANDUM FOR CAPTAIN THOMAS FLYNN

FROM: AFIT Liaison Officer (Major Bridges)

15 Jun 1996

SUBJ: Team Chief Assignment

1. Effective 15 Jun 1996, you are appointed team chief of the AFIT Team 2 IAW AFITI-36-105, para 2.10.1. As team chief, you report directly to me, and are responsible for the personnel assigned to your team. The duties of the team chief fall into three broad categories:

a. Accountability

(1) You will maintain weekly contact with each member of your team. This contact may be in person, by telephone, or e-mail. These contacts should be initiated by team members; however, if a member fails to contact you for over one week, contact that member to determine the reason for this failure. If you cannot resolve such failures, report the circumstances to me as soon as possible.

(2) You have the authority to grant 72-hour passes to your team members IAW AFITI 36-105, para 3.38.1. All forms of absence of your team members from the local area should be coordinated with you. You need to know the status of each of your team members at all times. They should notify you of their departures and returns, and provide you with some means to contact them in case of emergency. I will contact you to pass on information regarding such emergencies. You are to keep a log of those who are on pass; the log should contain the date the pass was requested, name and rank of the person on pass, dates effective for pass, and a phone contact number. This is important in order to contact individual in case of an emergency. The log retained for one calendar year and then forwarded to me through the AFROTC detachment.

(3) You will report to me or the Alternate Liaison Officer (ALO), Major Steve Pluntze, weekly. I prefer to receive your report by e-mail on Mondays before 2200 hours. but please let me know if this is inconvenient for you. E-mail reports are sufficient if you prefer; my E-mail address is ebridges@u.washington.edu . Your report must include the names of team members who failed to report the previous week, the status of anyone of leave, pass or TDY, any changes of address or phone number of your team members, and any problems related to your duties.

b. Personnel Counseling

(1) By maintaining weekly contact with your team members, you should be aware of any personal problems (e.g. medical, financial, family, etc.) which might affect their military or academic performance. Notify me of any significant problems in these or related areas. In addition, notify me of anything you feel would affect the potential for commissioning of any ACEP (OT) or CSEP (A1C) student.

(2) When any team member under 26 years of age departs on leave, pass or TDY, they must receive a safety briefing. Have the member read the Safety Briefing located in the AFIT Read File and complete the Predeparture Safety Briefing form. Extra copies of the form are available in the AFIT Read File binder at the AFROTC detachment.

c. Command and Casualty/Duty Status Reporting

(1) Monitor your team member's compliance with AFR 35-10 and wear of the uniform each Friday class day. Those working or attending classes in the hospital are exempt from this requirement.

(2) Immediately report to me any violations of the UCMJ or civil law.

(3) Immediately report to me any serious illness, injury or hospitalization of a team member. If you cannot reach me, contact the ALO (see roster) or the Professor of Aerospace Studies (PAS) at AFROTC Det 910, Phone 543-2360.

(4) Obtain, report, and disseminate information as required.

(5) Appoint a member of your team to handle your responsibilities in your absence. Make sure this person is fully aware of his or her duties.

2. The team chief is an important link in the chain of command. You have important responsibilities in this regard, but you should find the demands on your time are not excessive. Remember, if you have problems or questions, please call me.

Elizabeth J Bridges

ELIZABETH J BRIDGES, Major, USAF, NC
AFIT Liaison Officer

cc: PAS

Date: Sat, 17 May 1997 11:33:54 -0700 (PDT)
From: "J. Johnson" <coljj@u.washington.edu>
To: tflynn@u.washington.edu
Cc: ebridges@u.washington.edu
Subject: Tng report input--Capt Flynn (fwd)

FYI.

What I sent to AFIT

JJ

----- Forwarded message -----

Date: Sat, 17 May 1997 11:32:51 -0700 (PDT)
From: "J. Johnson" <coljj@u.washington.edu>
To: jjohnso@afit.af.mil
Subject: Tng report input--Capt Flynn

John,

We haven't had the pleasure of meeting, but I would like to offer some inputs on the Tng Rpt you have to do on Capt Tom Flynn who is finishing up his Masters here at the University of Washington.

I'm down to 28 AFIT students here at UW now, but I think that probably keeps me at the head of the pack for the largest group to have to keep track of. But I find that it's easy with the help of folks like Major Elizabeth Bridges (LO) and Tom Flynn (one of the Team Chiefs). Tom has kept his team informed and helped work their concerns, and this makes my job easier.

But one of the "above and beyond" things Capt Flynn did for me this year was to act as the Investigating Officer in the case of a cadet we had to investigate for disenrollment. The case revolved around the cadet's academic and weight problems, and it was not an easy audit trail to follow. But Tom aggressively gathered all the facts from the AFROTC Detachment staff and the UW professors involved to ensure a truly unbiased report was prepared for HQ AFROTC to review. This was a very time consuming project, but Tom did not hesitate to spend the time required to get it perfect. And obviously it did not affect his academic work because he has just successfully defended! This effort has helped broaden his professional officer skills and should go a long ways to increasing his potential for future leadership positions within the AF.

Hopefully this will help give you some meat for his training report. He is a dedicated officer and deserving of the strongest report you can write.

As you are probably well aware UW's School of Nursing is rated Number 1 in the nation, and hopefully you will be able to continue to send a large

FROM: Maj Bridges

TO: Capt Flynn, Capt O'Rear, Capt Averett-Brauer, Capt Lemke

SUBJ: Letter of Appreciation

15 Feb 1997

I would like to thank each of you for your tremendous presentation to the ROTC nursing students. Each of you brought such unique perspectives, I do not think I could have come up with a broader representation of areas of expertise or experiences. You each demonstrate the highest qualities of officership, and I know the cadets view you as role models. Your enthusiasm and your commitment to the Air Force were clearly evident in all of your stories. Cadet Michael asked me to thank each of you for your time. The cadets present were all very appreciative of your willingness to share your time and experiences with them. I also heard from Capt McCann that you were such a big hit that the cadets who were not able to attend want a reprise of your performance. Again, thank you for doing such a great job.

Sincerely,

Elizabeth J Bridges

ELIZABETH J BRIDGES, Maj, USAF, NC
University of Washington/AFIT Liaison Officer